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Measurement Issues in Performance Based Logistics

30 June 2004

by

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Abstract

Performance Based Logistics is an acquisition reform that is intended to improve weapon systems logistics by reducing cost, improving reliability, and reducing footprint. It is an extension of a broad process of rationalizing, and in many cases outsourcing government services. As with other examples of governmental service outsourcing measurement issues arise, in the gap between governmental objectives and service measurement, and in the contrast between clear profit-centered vendor metrics, and more complex mission-oriented governmental metrics. Beyond this however, PBL presents new challenges to the relationship between governmental agencies and their service vendors. In many cases, weapons systems logistical support involves levels of operational risk that are more difficult to measure and more difficult to value than other government services. We discuss the implications of operational risk and other measurement issues on PBL implementation.

Keywords: Performance Based Logistics, PBL, Acquisition Reform, Weapon Systems Logistics, Outsourcing, Risk Management, Future Logistics Enterprise

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Introduction

Performance Based Service Acquisition is a Department of Defense (DoD) acquisition reform that has had noted success in reducing cost and streamlining the management of non-core government service capabilities (Office of the Deputy Under Secretary of Defense – Defense Acquisition Reform [OSD-DAR], 2000). The guiding principle in Performance Based Service Acquisition is that when an outside vendor exists who can perform a service more effectively than a government user could organically, that user should specify measurable outcomes to a service vendor, and allow the vendor to best determine the appropriate processes (how) of delivering the service. In adopting this reform, DoD has been influenced by the perceived success of outsourcing in the private sector. Firms have witnessed gains from devolving non-core activities to suppliers, while achieving high levels of transparency so that visibility of inventory and information is maintained throughout the supply chain (Spekman & Davis, 2004).

Performance Based Logistics (PBL) is an extension of Performance Based Service Acquisition aimed at the logistic services for major weapon systems. The Quadrennial Defense Review mandated DoD to implement PBL, in order to "compress the supply chain and improve readiness for major weapons systems and commodities." (Office of the Secretary of Defense, 2001: 56) PBL is intended to reduce lifecycle cost, increase readiness, improve reliability and reduce the logistical footprint of weapon systems. A number of case studies of successful PBL initiatives are available (e.g., Candreva, et al., 2001).

This paper takes for granted the ubiquitous nature of PBL initiatives, and takes as its starting point the question of how best to measure the degree of their success. In support of our prescriptions for measurement, we will draw not only on successful best practice, but also on the underlying logic and justification of outsourcing, as laid out in the economics and management literature. While PBL prescriptions from OSD are always careful to explain that a PBL initiative may result in the selection of an 'organic

contractor' (i.e., another DoD command), actual instances of 'organic contractors' are fairly rare, and in any event, some of the same measurement issues arise regardless of the blend of private sector and organic resources.

While measuring the performance of ongoing PBL initiatives is our starting point, we also intend this paper to inform valuation questions. From the initial question of whether to bring forward a weapon system or a major component of a weapon system as a candidate for PBL, to later design questions of 'what form' of PBL is best applied to that candidate, measurement issues are endemic. After all, the logistic services to be outsourced will be priced contractually, and for some services, there is no clear market to determine that price. When discussing CONUS transportation, prices are perhaps not difficult to determine by reference to a market. However, when discussing something like intermediate-level maintenance of a deployed weapon system on which the DoD has a monopsony and the number of qualified bidders is quite limited (and may indeed be only one or two), the market paradigm clearly breaks down, and is perhaps best understood in the context of game theory (Shubik & Levitan, 1980). Unlike the simple solutions of monopolistic games, however, the monopsonistic game of buying weapon systems logistics is hampered by the difficulty of measuring the value of the services to be obtained.

In discussing whether a case could be made for the privatization of a particular governmental service, Bendick (1984) said it was important to compare private to 'nonmarket' (i.e., organic) alternatives, and that the private sector should only be employed if it could reasonably be expected to be more efficient. He listed

> "four aspects of market efficiency [that] are important to examine:
>
> - In producing the services … do the private sector's production processes and input costs allow it to generate output at a lower total cost than could the public sector?
> - Are the administrative costs incurred by government to mobilize and control the private sector les than the cost savings from more efficient production?

- Is the supply side of the market sufficiently responsive that private firms enter markets rapidly and smoothly?
- Are purchasers sufficiently rational and careful, and the quality of the service sufficiently definable and measurable, that effective, informed consumer sovereignty can be exercised? (Bendick, 1984, pp. 153-154)."

Each of these considerations is potentially problematic when examining PBL initiatives. When considering the first of the above factors, the existence of PBL contracts in which the private sector vendor has hired back organic resources as subcontractors to do the touch labor puts in question exactly what services are being outsourced – logistics or management? When considering the third of his factors, the consolidation of the defense industry and the decline of the number of independent companies that might act as potential bidders raise concern. However, this paper will primarily concern itself with the second, and especially the fourth of these factors. We will discuss how an excess of measurement can make administration of comprehensive PBL contracts more costly, while the difficulty with defining and measuring some logistic services make consumer sovereignty difficult to establish.

The rest of the paper will be organized as follows. First, we will lay out a structural framework upon which measurement issues will be developed. Upon that framework, we will then develop questions about how measurement informs which sorts of candidates are best suited for PBL. Finally, we will discuss how measurement issues should be considered when deciding on the form of PBL to be adopted for a particular candidate, and the management of ongoing PBL contracts. We are not attempting to clearly delineate between good and bad measures, or good or bad candidates for PBL. Rather, we are attempting to surface imbedded measurement-related issues that may make the difference between a problematic implementation and an easy one. Thus, this paper is not intended as a guidebook for implementation, but rather as a guidebook for further investigation.

A Hierarchical Bridge Framework of Measurement for PBL

When describing logistics service acquisition for a weapon system as an economic game, it is important at the outset to note the dissimilarity between the two players. The vendor has a clear objective of maximizing the wealth of its owners, and a clear profit incentive (again, we assume throughout the paper that we are dealing with a private-sector vendor). The objective of the user acquiring the service is not so easy to state, and far more difficult to assess. Ambiguities in goals and a lack of linkage between services acquisition goals and strategic objectives are intrinsic aspects of the services acquisition process (Camm et al, 2004; Ausink et al 2002). Maximizing national security would be one way to state the objective, and the incentive (at least at the organizational level) might be understood in the same terms – to gain more security for the nation. At the outset then, the game has a measurement and a translation problem – measuring the services in terms of their contribution to the objectives and incentives of the DoD, and translating that measure into the dollar measurement used by the private sector.

Of course, it might be claimed that business does not really have such clear objectives and incentives either. There is a venerable literature pointing out the maximization of shareholder wealth should not be (and is not in practice) the sole aim of a public corporation. Stakeholder analysis has its roots in this observation (Donaldson & Preston, 1995). But even stakeholder analysis (in narrow form at least) does not deny the centrality of profit as a corporate incentive, rather the discussion centers on rights of resource holders, and equitable distribution of profits.

The management fashion of Balanced Scorecards has demonstrated the willingness of corporate executives to look beyond profit in analyzing performance (Kaplan & Norton, 1992). But it would be a mistake to take the current proliferation of Balanced Scorecards as evidence that corporations suffer under the same sorts of fundamental measurement problems with their objectives and incentives as the DoD.

The Balanced Scorecard is clearly meant to be a *diagnostic tool* to inform management decisions beyond retrospective financial figures about the long term viability of the firm (i.e., it is meant in part to help predict and control *future* financial performance). Kaplan and Norton (1992) discuss the shortcomings of financial performance measures in terms of their ability to guide (1) the innovation necessary to obtain future profitability, (2) the diagnosis of internal process problems that limit current and future profitability and (3) the relationship with the customer necessary to sustain future profitability. Their main criticisms of current financial measures (which are a part of the Balanced Scorecard) are that they are historical and external to operations. They tell a firm how well it has performed, not why, or what to do next to maintain or improve future performance.

But measurement-related differences between the DoD and the corporate world exist not only in the incentives and objectives of each, but also in the process capabilities that are important in developing logistics tactics to meet those objectives. In reviewing essential dimensions to be considered in logistic performance analysis in the commercial sector, Mentzer & Konrad (1991) developed a matrix in which five core logistics functions (transportation, warehousing, inventory, order processing and administration) could be measured along six dimensions (cost, labor, facilities, equipment, time & energy). Distinguish between those dimensions and the four "overarching goals of PBL … to compress the supply chain, eliminate non-value added steps, reduce Total Ownership Cost and improve readiness for weapons systems…(Department of Defense – Defense Contract Management Agency [DoD-DCMA], undated)" to which one should add "increased reliability and reduced logistics footprint (Office of the Secretary of Defense [OSD], 2003)". Aside from cost, these sets of six factors seem to have little in common. But all of the commercial sector factors can be translated into cost, and can be understood as the essential dimensions that must be managed efficiently and effectively, in order to facilitate logistics support of the firm's profitability objective. The DoD factors, on the other hand, do not all translate so readily into cost, and fall into three categories of dimensions that logistics improves warfighting capability: improved readiness (facilitated both directly by a focus on

readiness and indirectly by a focus on reliability), increased agility (reducing logistical footprint, eliminating non-value-added steps, supply chain compression, and improved reliability) and reducing cost (by freeing capital for other warfighting priorities).

This is a significant difference in how logistics is viewed. The concept of readiness shows up as 'equipment' to commercial firms, who view the maintenance and functioning (and depreciation) of their operating capital primarily as a financial question – when will it become so expensive to maintain that I will have to replace it? Since DoD weapon systems are often quite old, very expensive and difficult to re-capitalize (lacking a depreciation mechanism, recapitalization is often driven by technological obsolescence or budget constraints), readiness is a much more central issue. Improvements in readiness, of course, improve warfighting capability; but marginal improvements are quite difficult to value in dollar terms. The idea of 'agility' is increasingly important to commercial firms, but agility in a commercial operation means, for example, the flexibility to quickly change production volumes, or quickly changing production technology. It shows up in the list above as 'time', which is also translatable to dollars. DoD operations on the other hand are mobile, and mobility directly impacts their effectiveness. Agility is not a newly discovered competitive dimension – it has always been an operational necessity. Once again, however, the operational effectiveness derived from a marginal improvement in logistics agility is very difficult to translate into dollars.

These differences in organizational objectives and the consequent logistics objectives further devolve into differences in process measurement. Caplice & Sheffi (1994), in a classification and review of corporate logistic process metrics develop three categories: utilization, productivity, and effectiveness (see Table 1). Utilization measures simply address the question of how much of a resource is used, compared to what has been made available. While these sorts of measures may be useful in assessing the efficiency of a narrow segment of a process (e.g., space utilization may be useful in assessing the efficiency of a facilities layout manager), they have virtually no contribution to the understanding of logistics contribution to organizational objectives, primarily because they do not measure outputs at all. It might be claimed that they

measure waste, but even this is not true – all they measure is activity, not whether that activity is directed toward some valued outcome. What Caplice and Sheffi (1994) have called effectiveness measures, on the other hand, 'beg the question' in an essential way – those measures are only as good as the norms one establishes for outputs. They may be useful for historical comparison of a single process, but their value in comparing across processes or in guiding resource allocation decisions is quite limited. Productivity measures, on the other hand, incorporate both outputs and inputs. For the corporation, assessing the contribution of an activity to its objectives is a matter of relating those inputs outputs to profits. While of course this is not necessarily easy (e.g., single factor productivity measures do not capture a comprehensive cost picture), at least the examples given by Caplice & Sheffi (1994) can be measured or translated to dollars (e.g., dollars paid for orders processed, or shipments made), and this is broadly true of metrics proposed in other reviews of corporate logistic performance measurement systems as well (e.g., Chow, Heaver & Henriksson, 1994; Lambert & Burduroglu, 2000; Mentzer & Konrad, 1991), with the important exception of customer satisfaction metrics. The importance of the 'customer view' has already been mentioned in relation to Balanced Scorecards, is often mentioned by authors on logistic performance measurement (e.g., Mentzer, Flint and Kent, 1999). However, it is worth noting that Lambert & Burduroglu (2000) list "reliance on management outside of logistics to identify the impact [of customer satisfaction] on revenues, which typically does not happen" as a primary disadvantage of customer satisfaction measurement. Hence, beyond simple utilization measures, corporate logistic performance measures can, or are desired to be, understood in terms of their impact on profitability.

Table 1. Corporate Logistics Metrics (from Caplice and Sheffi, 1994)

Dimension	Form of Metric	Logistics Examples
Utilization	Actual Input / Input Norm	Labor hour used / labor hours budgeted Area of warehouse occupied / total area Hours machine used / machine capacity
Productivity	Actual Output / Actual Input	Ton-miles delivered / costs incurred Orders processed / hours of labor Pallets unloaded / hour of dock time
Effectiveness	Actual Output / Output Norm	Items filled / items requested Shipments on time / shipments sent Transactions w/o error / total transactions

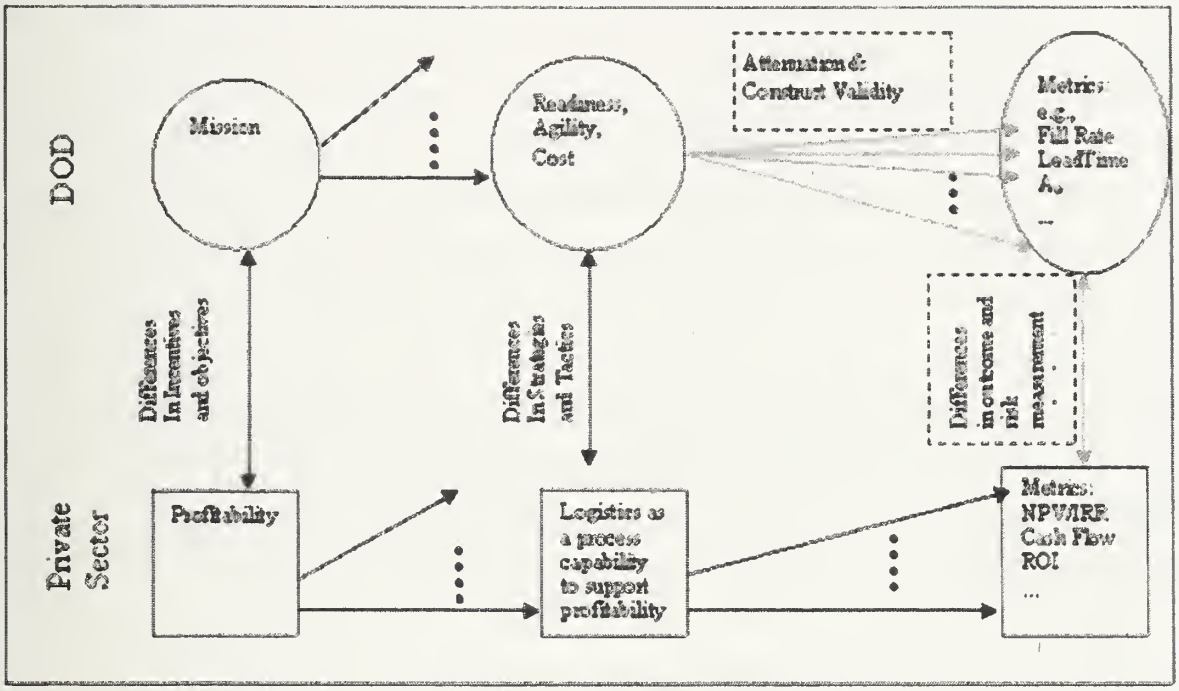
Compare those corporate logistic measures to what might be proposed as a productivity ratio for weapons systems logistics –

Operational Availability (Ao) of deployed systems / Total deployed hours.

At first glance, this looks like a utilization measure, not a productivity measure – but Ao is often used as a surrogate for readiness, which is typically given as a primary *outcome* objective of military logistics (it would be a utilization measure if, e.g., flight hours were in the numerator). The denominator translates to dollars in a budget (whether or not they could be translated to an actual cost is another issue). But the numerator is not and should not be translatable to dollars, because profit is not the objective. While measurable, it is difficult to value in terms of the dollars that might be spent to increase it, or relinquished in order to pursue other priorities. Another problem is that Ao is only a surrogate for readiness because it is a 'single factor' measure. It is also not fine grained enough for many resource allocation decision we wish to make (hence the distinction between 'mission capable' and 'fully mission capable' systems). And finally readiness itself, after all, is only a surrogate for the organizational objectives of the DoD (i.e., ready for what?). Note that if Ao were really the objective, it could be maximized by parking equipment. Hence, logistic performance of weapon systems is

more difficult to measure than commercial logistics (at least in terms of productivity), and perhaps more attenuated from DoD objectives than are commercial logistic measurement systems.

Figure 1. A hierarchical framework of measurement issues



How do these measurement issues inform the decision to bring forward a weapon system or component as a PBL Candidate? First, again considering only outsourced PBL solutions, we must consider the economic logic behind outsourcing. One basic economic justification of outsourcing is the tradeoff of economies of scale with a reduction in transaction costs. If the outsourced service can be performed by an organization that offers similar services to a number of other customers, that organization gains economies of scale, and should be able to offer the service more cheaply than if it were done by the outsourcing organization in house. The price that is usually paid for such outsourced services is usually in terms of increased transaction costs to negotiate price and services, and monitor performance (Gustafson, Aubert, Rivard & Patry, 1996). When economies of scale are difficult to obtain, as with a unique weapon system requirement, some of the underlying justification for outsourcing disappears. On the other hand, high internal transaction costs, due to e.g., high

reporting requirements, or inefficient internal controls make outsourcing relatively more attractive. If high internal transaction costs are part of the justification for outsourcing a PBL contract, then it is important that the system or component being outsourced avoid some of those transaction costs. When measurement of logistic outcomes (readiness, agility and cost) is more difficult, it will mean higher transaction costs, because performance monitoring systems will have to be more elaborate, and fair prices will be more difficult to determine and negotiate.

One way to make pricing and performance monitoring easier is by reference to a market for similar services. Hence, in prescribing a methodology for the analysis of performance based contracts for contract managers, market research is indicated as a required step (OSD-DAR, 2000). For comprehensive weapon system logistical support, or for weapon system-unique components, there will likely be no ready market for maintenance, or many other logistical support functions. In those cases, the implementation of an outsourced PBL solution will require more cost and effort to develop appropriate metrics, and negotiate appropriate prices.

In summary, measurement issues are endemic to the relationship between commercial sector vendors and the DoD. From the point of view of measurement, the best PBL candidates are those with external markets for services, and clear outcomes that are easy to relate to mission objectives. This is not to place a definite boundary on the systems where PBL ought to be applied, but only to point out that measurement issues may make some PBL implementations far more difficult and expensive, and may affect the form of the PBL solution.

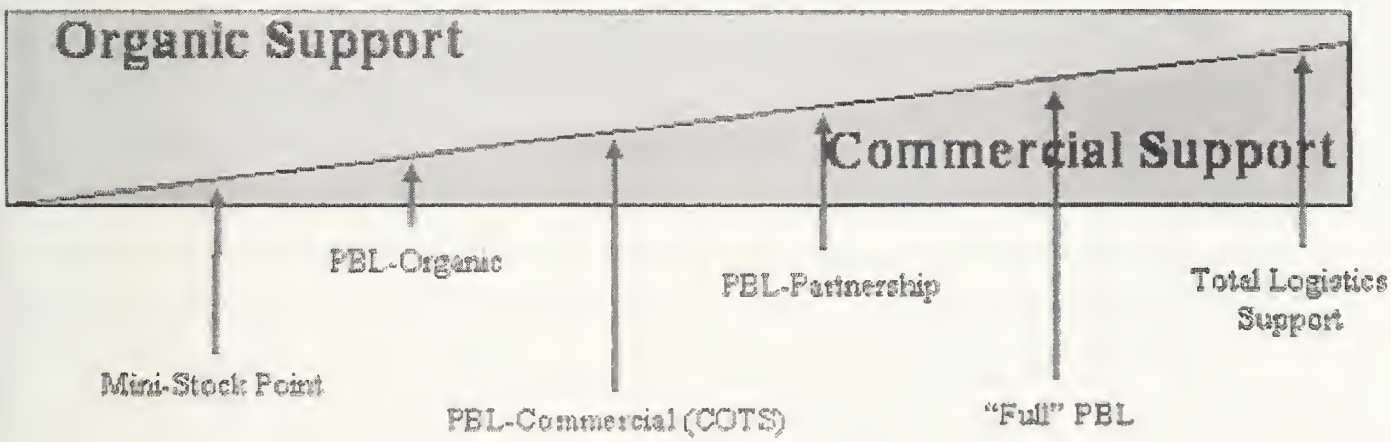
Measurement, the PBL support spectrum and the management of ongoing contracts

One of the characteristics of PBL is that general characterizations are hard to make. The top level guidance for the initiative always has caveats such as

> "there is no one-size-fits-all approach to PBL. Several programs have started the move to PBL under initiatives designed to meet the programs' specific requirements. Each program has tailored the PBL application to its unique circumstances taking into account cost, schedule, or product integrity to meet warfighter capability. (DoD, 2001, p. 2-2)"

In reviewing implementations, a wide variety of approaches can be found, in terms of measurement and incentives, and in terms of the level at which the PBL contract is written: from a complete weapon system as with the DDG-51, to component level stock support, as with the AEGIS. The spectrum of choices is usually described in terms of the degree of commercial support involved, and a frequently encountered graphic (which we have been unable to track to its original source) is shown in Figure 2.

Figure 2. The PBL Support Spectrum.

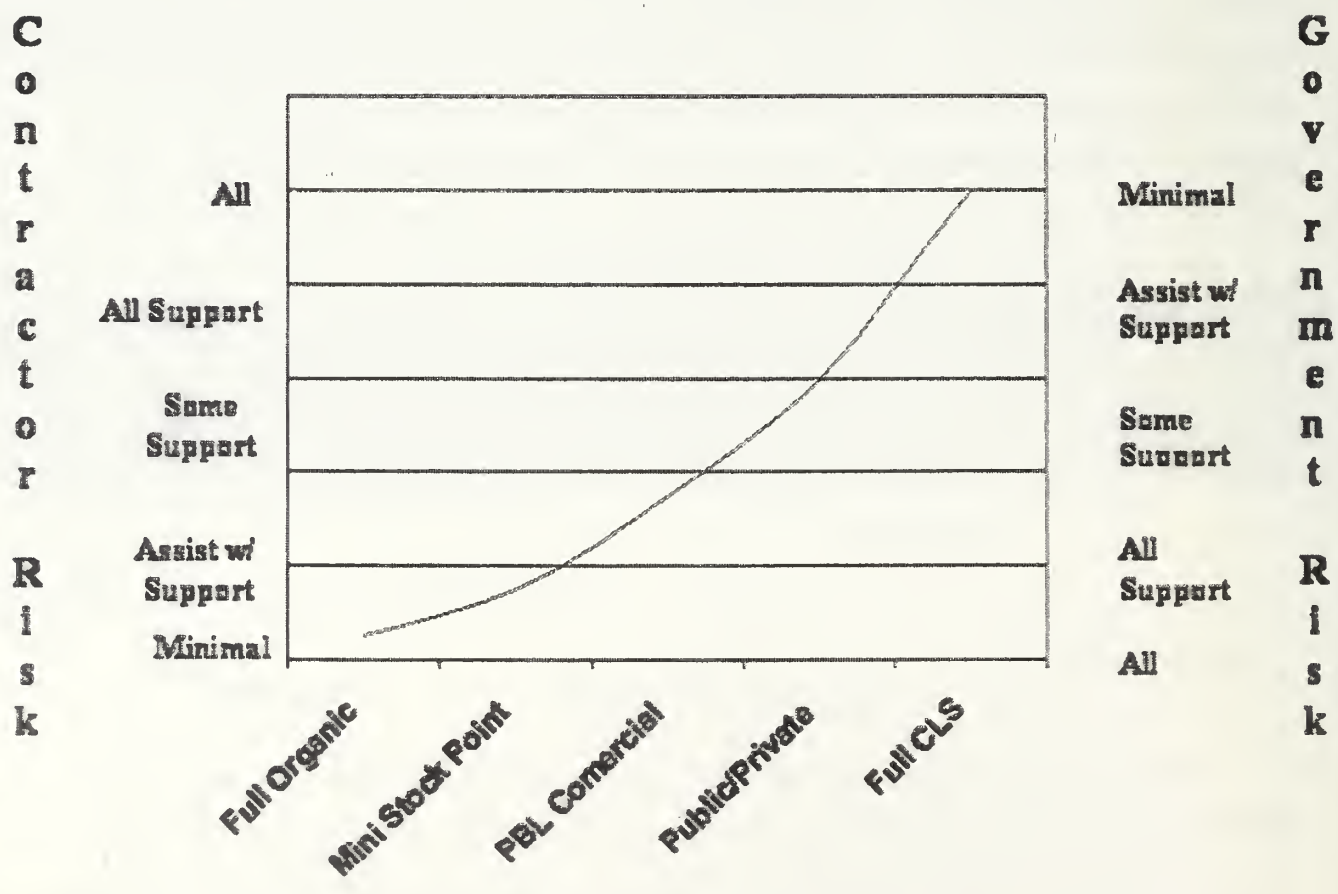


While examples of systems are often given in association with this chart, and definitions of the various anchor points (e.g., Mini-Stock Point) are offered, very little guidance can be found for the program manager as to what characteristics of a weapon

system should inform the choice of the degree of commercial involvement, and whether the contract should be offered at the system, or component level. It is our position that measurement issues should inform this choice.

A primary aspect of measurement informing the choice of commercial involvement, which we have not discussed yet, is risk. As should be clear by reference to Figure 1, vendors will be primarily interested in reductions of financial risk, while the DoD is entirely concemed with operational risk. The tradeoff of these two kinds of risk is central to the logic of PBL outsourcing. Contracts are almost always offered across multiple years (lowering financial risk for the vendor), with the expectation that the vendor will assume some degree of operational risk. Figure 3 shows the expected tradeoff of operational risk.

Figure 3. Intended risk transfer under PBL. From DoD-DCMA (undated).



Although risk is clearly indicated as a factor to consider when developing a PBL strategy (ASN-RDA, 2003; Office of the Assistant Deputy Under Secretary of Defense – Logistics & Material Readiness [OSD-LMR], Undated), this factor is rarely mentioned as a candidate for measures of ongoing performance in PBL contracts. Indeed, it has been said that

> "minimal contract management involvement is anticipated as long as the contractor meets contractually specified performance metrics. However our involvement may increase if the contractor systems and processes are not functioning correctly and end users are not appropriately supported (DoD-DCMA, undated, pp 28-29.)"

This is a curious form of risk transfer. Operational risk, as we understand it, involves the variance associated with outcomes. The assumption of operational risk by a contractor then would entail accountability for control of that variance, and assurance (with appropriate remedy in the case of failure) of the mitigation of its impact. Here, rather, it seems that vendors are being asked to assume some aspects of risk (not clearly defined), but that the DoD will 'increase involvement if the contractor' fails to meet requirements. We do not claim that this is risk transfer in name only, but that the form of risk being assumed by vendors is not what is commonly understood as operational risk, and the degree of risk they are assuming is apparently quite limited.

It is our view that the degree of operational risk a contractor can assume is limited in many cases by the nature of military operations. It is unrealistic, for example, to assume that contractors will be able to perform operational level maintenance on a ground combat weapon system; difficult issues relating to the physical risk, insurance, and liability of non-DoD personnel in or near combat need to be addressed. These sorts of operational risk are difficult to measure, and even more difficult to value. We think it likely therefore, that commercial sector vendors will be reluctant to undertake these risks. Depot level maintenance, and operation of CONUS inventory control points involve less operational risk, and risk in a form that is easier to measure, and less costly for a vendor to assume, and hence we think it likely that the more operational risk

involved in the logistical support of a particular system, the more organic resources will need to be involved.

Proposition 1. When operational risk is high or difficult to measure, PBL strategies should seek less commercial sector involvement.

Within the context of a price negotiation, it is also key to understand the benefit the DoD provides by eliminating financial risk, as this is part of what we are paying to potential vendors. Especially if interest rates and rise and the difference between the cost of capital and risk-free rates increase, what the DoD offers in terms of financial risk mitigation is highly valuable. This valuable benefit is not free for the government to offer, and should be incorporated into pricing and contract negotiations. If less operational risk is assumed by the vendor (or if that risk is difficult to assess), less financial risk should be mitigated – meaning contract terms should be reduced.

Proposition 2. When commercial sector vendors assume less (measurable) operational risk under a PBL contract, the term of that contract should be less.

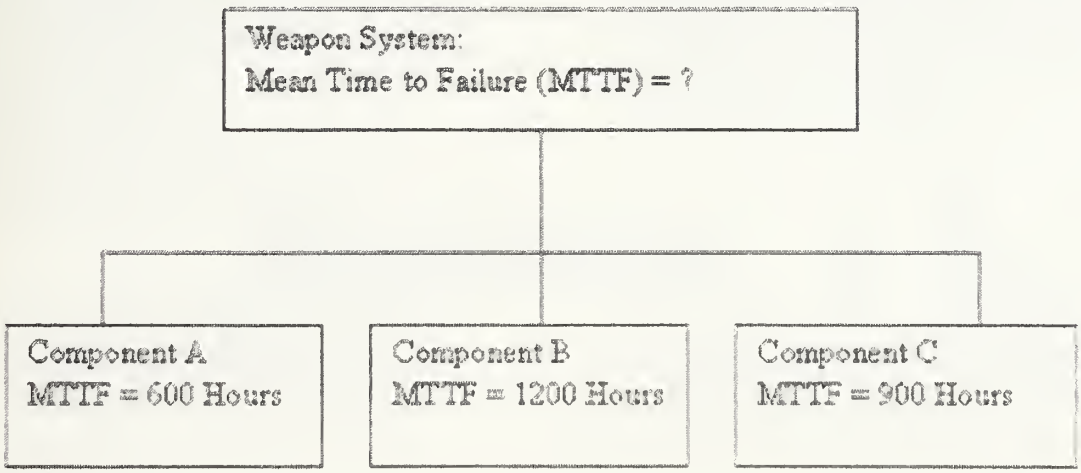
On the other hand, the outcomes of PBL strategies involving only certain components, or only depot-level support, are more difficult to tie to weapon system outcomes. Consider Figure 4, which shows a highly stylized and simplified version of a weapon system and its major components, along with the failure rates (mean time to failure) of each of the components. Assuming failure of any of the components cause the weapon system to become non-mission capable, the failure rate of the overall weapon system is then an order statistic, formed of the *distributions* of the time to failure of *all* of the components. Now consider the problem faced by a program manager who has decided that his best PBL strategy involves outsourcing only component A (the one with the highest failure rate). To properly value the impact of, for example a proposed incentive to improve the reliability of component A by 10%, the program manager would need not only distributional information about the time to fail of all the other components, but also a working model which imbeds that system in mission requirements. After all, the final value of an improvement in reliability of a component

(to readiness – of course there are other benefits in terms of reduced life-cycle cost of spares, and improved agility through reduced footprint) rests in the increased likelihood of mission success in the deployed weapon system. The sort of integrated simulation model needed to properly assess the impact of improved component reliability would be expensive, and more importantly, time consuming to build. Given the time pressures put upon Program Managers, it is easy to see that the situation is problematic.

Proposition 3. PBL strategies involving less than comprehensive logistical support of a weapon system (e.g., for a component) should nonetheless have integrated weapons system models in support of their business case analysis.

In summary, measurement issues exist across the PBL spectrum, but present different sorts of challenges at either end. Ultimately there are at least two core measurement issues that should be referred to when deciding on an appropriate level of support within the PBL spectrum. The first is the valuation of outcome-related performance, and the second is valuation of operational and financial risk. While outcomes are easier to measure at the right end of the spectrum, one is less likely to find a relevant market to support price and value decisions. On the left hand of the spectrum, markets may well exist that essentially duplicate, for example, the services of a mini-stock point. However, the valuation of those isolated services in terms of weapon systems performance is even more difficult.

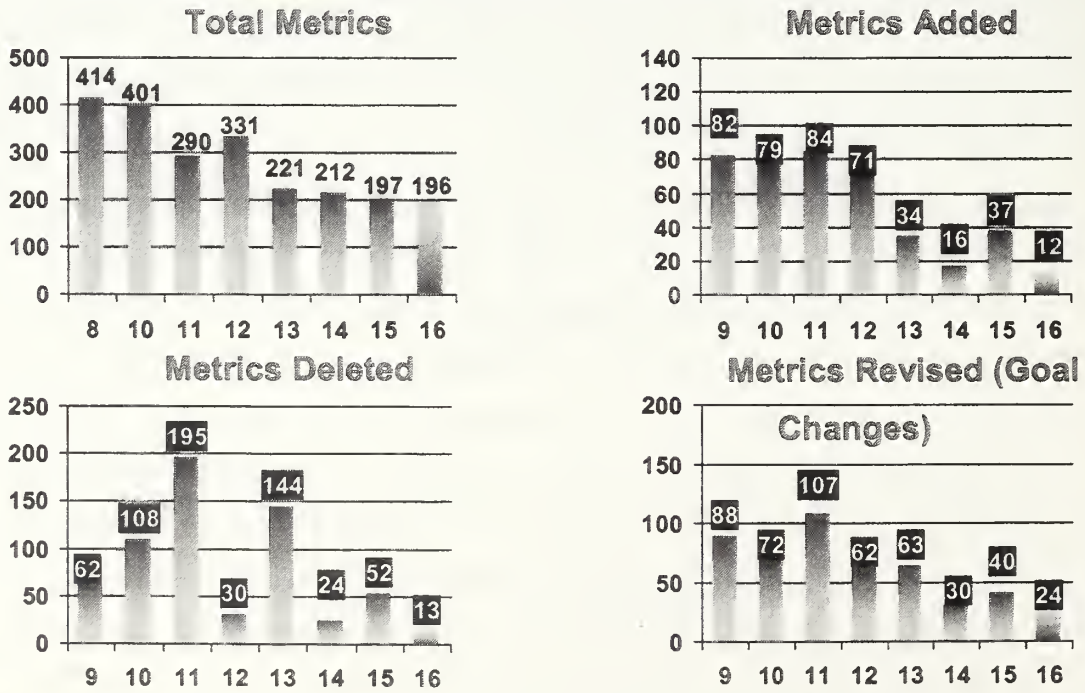
Figure 4. Need for integrated system model to judge impact of component outcomes.



Aside from risk, another distinction important to develop when discussing management of ongoing PBL contracts is the difference between process and outcome measures. It is our position that, while PBL is clearly intended to buy outcomes, and relieve management of the necessity of monitoring the details of 'how' performance is obtained, a great deal of effort is still being devoted to process measurement. It has recently been said that 'too many metrics' is a major problem with PBL implementation (Office of the Secretary of Defense, Undersecretary for Acquisition, Technology & Logistics [OSD-ATL], 2004). If the DoD is buying outcomes, not process, then it may be that much of the process measurement is unnecessary.

An example of 'too many metrics' is shown in Figure 5. This is a slide shown in a brief to a base commander to provide an overview of the PBL contracts at his base. This is a small base, with only a handful of PBL contracts. Clearly, the commander understands that there are too many metrics, and is tracking them quarterly in order to push for their reduction. Here, the number of metrics itself has become a metric, with visibility to the top operating officer at a command.

Figure 5. A measure of PBL measures used at one DoD command.



Exactly how the superabundance of metrics arises is an open question. PBL is a process meant to streamline management concern with the details of a logistical process. In part, it may arise from a broader context within DoD, of understanding the systemic relationships of which logistics is only a part. Under various titles, including Integrated Logistics Support, the last several years has seen an increasing awareness of the embedded nature of logistical support, and the inter-relationships involved between e.g., manpower, maintenance, and supply. Figure 6 is taken from a presentation to a PBL 'tiger team' concerned with establishing metrics. Figure 6a lists the 'balanced scorecard' of top level factors for weapon system support.

Figure 6a. DoD Balanced Scorecard for Weapon System Support. From PRTM (2004).

Warfighter

- L1: Force Readiness
  - L2: Equipment Readiness
  - L2: MC Rates
  - L2: Commodity Availability
  - L2: Logistics Units Readiness
  - L2: Prepositioned Readiness
- L1: Force Sustainment
  - L2: Materiel Support
  - L2: Services Support
- L1: Force Closure
  - L2: Distribution Capacity
  - L2: Distribution Visibility & Control
  - L2: Distribution Effectiveness
  - L2: Combat Effectiveness
  - L2: Prepositioned Effectiveness
- L1: Reset
  - L2: Reset
  - L2: Operational Draw-down

Innovation & Learning

- L1: Innovation Realization
  - L2: Rate of Transformation
  - L2: Rate of Improvement
- L1: Workforce Capability
  - L2: Workforce Shaping
  - L2: Learning Transformation
  - L2: Employee Climate

Logistics Process

- L1: Logistics Chain Reliability
  - L2: Perfect Order Fulfillment
- L1: Logistics Chain Effectiveness
  - L2: Logistics Chain Agility
  - L2: Logistics Chain Cycle Time

Resource Planning

- L1: Logistics Chain Predictability
  - L2: Planned Cost to Actual Cost
  - L2: Demand Forecast Accuracy
- L1: Logistics Chain Cost-Effectiveness
  - L2: Total Logistics Chain Cost Percentage
  - L2: Total Logistics Chain Cost
  - L2: Value Added Productivity

Figure 6b, translates the scorecard into logistics measures, by mapping between the high level scorecard factors, and the primary factors (process elements) of another management fashion called Integrated Logistical Support (ILS). The details of ILS process elements are not germane here, only to note that they are indeed *detailed* and *process* oriented. If one starts with a multidimensional balanced scorecard, and works through these process elements, it is easy to see how the number of metrics that must be tracked could be numbered in the hundreds – in fact, it would be hard to avoid. One must ask why however, if we are engaged in an initiative to buy performance, we are starting with a detailed map of the internals of the process. Wouldn't it make more sense to measure only key outcomes, and measure them well?

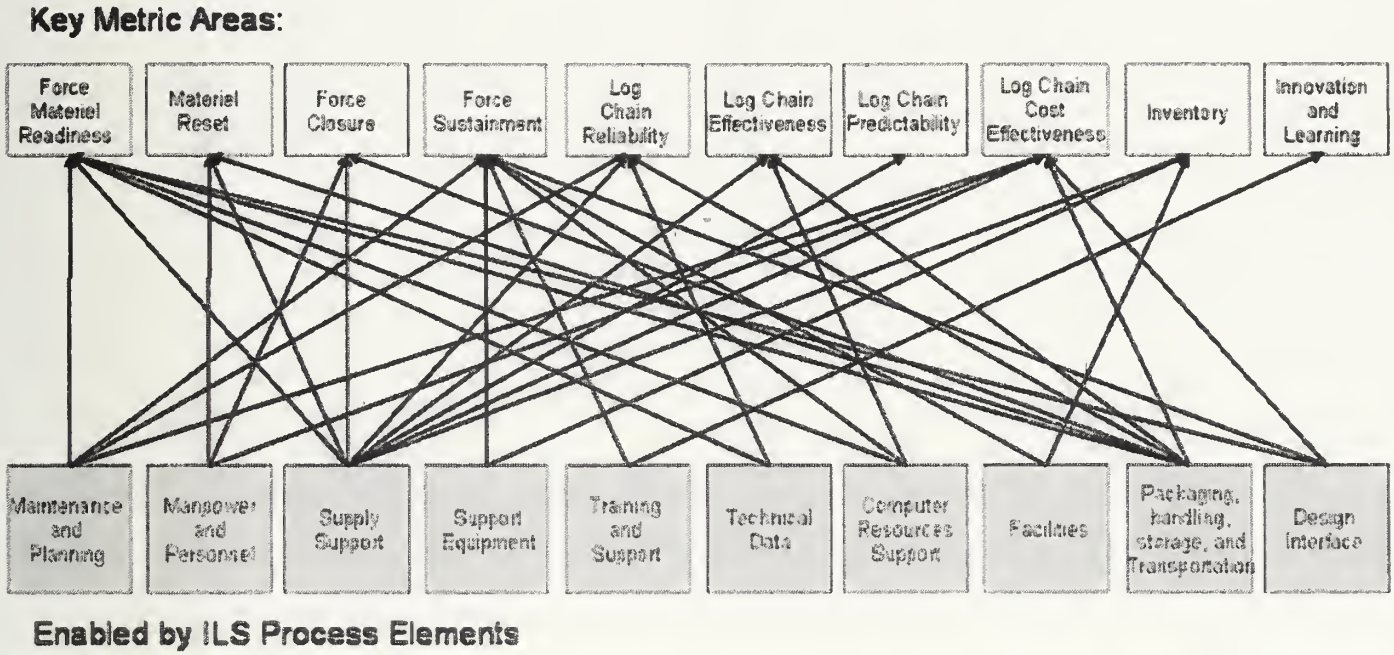
When we first presented this idea at a conference, we were met with the objection that an abundance of measures do not necessarily distract a decision maker from key tasks. The analogy was drawn to a pilot in a jet, where the cockpit has a superabundance of meters and instruments, almost all of which can be ignored, except in the case of an emergency. The analogy is a telling one, in that most of the people making decisions about metrics for PBL have themselves been pilots, or ship captains, or in charge of some complex process in the past. However, PBL is not supposed to present the DoD with a complex process to manage – it is supposed to take one off the hands of the DoD. We aren't supposed to be flying the plane – we are supposed to be passengers. When you are paying someone else to get you to your destination, you care about the price of the ticket, and arriving on time.

Of course this is a simplification. When discussing a PBL contract with one deployed squadron, we were met with a complaint about the difficulty of obtaining requisition status for parts that were backordered. The maintenance officer for that squadron was not impressed that the average lead time to get the parts had been reduced, because his primary decision when confronted with a backorder was whether or not to devote the manpower to strip a spare part from another downed aircraft. It was a decision that was difficult to make, without knowing how long it would be before the spare part arrived. Clearly, in this case, some visibility into the process was needed, *but only because a key operational decision rested on the measurement of that*

process. Given that at least part of the justification for PBL is meant to be a reduction in transaction costs, we think this should probably be a general rule.

Proposition 4. In the management of ongoing PBL contracts, metrics should primarily concern themselves with valued outcomes, and should be related to weapon system cost, readiness, and agility. Process measures should only be applied when key operating decisions depend on the status of the process itself.

Figure 6b. Metric Areas informed by Balanced Scorecard, and ILS Process Elements. From PRTM (2004).



Finally, we turn to the measurement of risk in ongoing PBL contracts. Operational risk is always difficult to assess. In the context of support for a weapon system, it can be understood as variance in the logistics-related readiness of that system. A common measure of readiness is Ao. To see how variability, or risk, affects Ao, consider Table 2. The table shows the availability of two squadrons of 10 aircraft over a 20 day period. Over that period, both squadrons would report operational availability of 95%. But consider that a mission requiring 10 aircraft would be degraded (more likely to fail) only 5% of the time in the first case, but 50% of the time in the second case. The difference

is the variance in Ao. To our knowledge, in spite of the exhortations of the centrality of risk assumption and readiness to PBL, there are no programs currently tracking this measure.

Table 2. Distributional differences in a 95% Ao.

Day	FMC aircraft In Squadron A (10 aircraft total)	FMC aircraft In Squadron B (10 aircraft total)
1	10	10
2	10	09
3	10	10
4	10	09
5	10	10
6	10	09
7	10	10
8	10	09
9	10	10
10	10	09
11	10	10
12	10	09
13	10	10
14	10	09
15	10	10
16	10	09
17	10	10
18	10	09
19	10	10
20	0	09

In a very thoughtful document, the office of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN-RDA, 2003) listed factors to consider when deciding whether to use a PBL strategy: life-cycle stage, acquisition program strategy (including programmatic risks), organic impact (e.g., maintaining engineering expertise), commercial base (including additional risk required of industry partners), design considerations (including risk associated with incentives and performance thresholds), and technology considerations (including supportability risks). Although risk is mentioned in four of the six factors, there is no mention of the sort of operational

risk discussed above, and shown in Figure 3. Indeed, there is little mention of risk for ongoing contracts in this, or any other guidance documents for PBL. We find this curious. If part of what we are buying is operational risk mitigation (in key performance dimensions), it seems to us that it ought to be measured.

Propositions 5. Operational risk (variability) in key performance measures should be tracked for ongoing PBL contracts. Where essential to mission support, a reduction in variability should be supported with appropriate incentives.

Conclusion

Organic acquisition and sustaining logistics in the Department of Defense of today is seriously challenged in its ability to provide significantly higher levels of operational availability and effectiveness commensurate with the complexity and high costs of weapon systems. In addition we exacerbate the pressure on logistics support as we prosecute our national security strategies with ships, airplanes, and equipment that are aging when a sufficient replenishment rate to counter that aging is unaffordable. Any change in the Defense Department Logistics discipline that can produce greater utility at lower costs should be the focus of an energetic pursuit. In order to bring about the necessary improvements we must mitigate cultural impediments and concurrently align measurement and rewards with good logistics performance in the acquisition process and operation of weapons systems in the field. It is also important to fully fund logistics requirements, safeguard the funding and engage in long-term contracts.

The Department of Defense faces major challenges in establishing a coherent logistics support strategy for its weapon systems. While Performance-Based Logistics has been decreed as a preferred implementation strategy, real questions remain unanswered about objectives and measurability. The disaggregation of logistics support, and the emphasis on an increased role for the private sector in logistics, also raise major issues related to the assumption of risk. In making sourcing decisions, DoD must act as a "knowledgeable client" and avoid simplistic decisions that may lead to critical systems being left unsupported.

In summary, this paper has presented a framework, and propositions about the impact of measurement on PBL. None of the propositions have the status of fully supported hypotheses, or fully developed theorems. All need further investigation. Some of the propositions are empirical, and need to be investigated in the field. Others are prescriptive, and need to be supported by modeling and analysis. Our hope is that we have furthered the discussion of metrics for PBL, and added to the momentum for improved implementations of PBL.

References

Assistant Secretary of the Navy – Research, Development and Acquisition [ASN-RDA], (2003). Performance Based Logistics Guidance Document. Unpublished manuscript.

Ausink, J., Baldwin, L. H., Hunter S., and Shirley, C. (2002). "Implementing Performance-Based Services Acquisition (PBSA): Perspectives from an Air Logistics Center and a Product Center". Santa Monica, CA: RAND Corporation (Report No. DB-388).

Bendick, M. (1984). "Privitazation of Public Services: Recent Experience," in Public-Private Partnership, H. Brooks, L. Liebman & C. Schelling, eds. Published for the American Academy of Arts & Sciences by Ballinger Publishing Company, Cambridge, Mass.

Candreva, P., B. Hill, B. Marcinek, B. Sturken & B. Vince. Auxillary Power Units Total Logistics Support Case Study. Working Paper, Tench Francis School of Business.

Camm, F. A., Blickstein, I. & Venzor, J. (2004). "Recent Large Service Acquisitions in the Department of Defense: Lessons for the Office of the Secretary of Defense". Santa Monica, CA: RAND Corporation (Report No. MG-107).

Caplice & Sheffi (1994). "A Review and Evaluation of Logistics Metrics," The International Journal of Logistics Management, V 5(2), pp. 11-28.

Chow, G., Heaver, T.D. & L.E. Henriksson (1994). "Logistics Performance: Definition and Measurement," International Journal of Physical Distribution & Logistics Management, V. 24(1) pp. 17-28.

Department of Defense [DoD] (2001). Product Support: A Program Managers Guide to Buying Performance. November, 2001. Unpublished Manuscript.

Department of Defense – Defense Contract Management Agency [DoD – DCMA] (undated). Performance Based Logistics Support Guidebook, in DCMA Directive 1, Chapter 2.3, Acquisition Logistics. Unpublished Manuscript.

Donaldson, T. & L.E. Preston (1995). "The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications," Academy of Management Review, 20(1), pp. 65-91.

Gustafson, K., Aubert, B.A., Rivard, S. & Patry, Michel (1996). "A Transaction Cost Approach to outsourcing behavior: some empirical evidence," Information & Management V. 30, pp. 51-90.

Kaplan, R.S. & D.P. Norton (1992). "The Balanced Scorecard – Measures that Drive Performance," Harvard Business Review, January-February 1992.

Lambert, D.M. & R. Burduroglu (2000). "Measuring and Selling the Value of Logistics," The International Journal of Logistics Management, V. 11(1), pp. 1-17.

Mentzer, J.T., D.J. Flint & J.L. Kent (1999). "Developing a Logistics Service Quality Scale". Journal of Business Logistics, 20(1), 9-32.

Mentzer, J.T. & B.P. Konrad (1991). "An efficiency/effectiveness approach to logistics performance analysis". Journal of Business Logistics, V. 12(1), pp. 33-62,

Office of the Secretary of Defense [OSD] (2001). Quadrennial Defense Review Report, September 30. Retrieved July 6, 2004 from www.defenselink.mil/pubs/qdr2001.pdf.

Office of the Secretary of Defense [OSD] (2003). "Designing and Assessing Supportability in DoD Weapon Systems," Unpublished Manuscript, dated May 29, 2003.

Office of the Secretary of Defense, Undersecretary for Acquisition, Technology & Logistics [OSD-ATL], 2004. PBL Purchasing Using Performance Based Criteria. Proceedings of the 2004 DoD Procurement Conference, Orlando, Florida.

Office of the Deputy Under Secretary of Defense – Defense Acquisition Reform [OSD-DAR] (2000). The Guidebook for Performance-Based Services Acquisition (PBSA) in the Department of Defense. Unpublished manuscript.

Office of the Assistant Deputy Under Secretary of Defense – Logistics & Material Readiness [OSD-LMR] (undated). DoD Template for Application of TLCSM and PBL In the Weapon System Life Cycle. Unpublished Manuscript.

PRTM (2004). Weapon System Support Metrics. Brief to the Executive PBL Tiger Team Meeting, 24 February, 2004. Washington, D.C.

Shubik, M. and R. Levitan (1980). Market Structure and Behavior. Harvard University Press, Cambridge, Mass.

Spekman, R. E., & Davis, D. E. (2004) "Risky Business: Expanding the Discussion on Risk and the Extended Enterprise," International Journal of Physical Distribution & Logistics Management, 34(5), 414-433.

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